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Major Report Abstract:

     An in-depth exploration into the automatic implantable
cardioverter defibrillator (AICD) is the purpose of this paper.
Developed to treat recurrent fatal ventricular arrhythmias by
delivering a countershock, the AICD provides increased protection
for patients who have survived sudden cardiac death. Because of
the increased numbers of people surviving sudden cardiac death,
ineffective antiarrhythmic drug therapy and an unpredictable
response to surgical interventions, AICD technology and
subsequent implants are increasing at alarming rates. Criteria
established by the Food and Drug Administration, along with
physical and psychological factors, govern whether or not these
implantations occur. AICD implantation, via one of four surgical
approaches, involves intraoperative testing and continual
postoperative surveillance of the patient's response and device
function. This surveillance continues after discharge via Magnet
and AIDCHECK tests to ascertain AICD battery level and its
subsequent functioning capability. A malfunctioning AICD unit
caused by infection, drug interactions, battery deactivation,
battery depletion, pacemaker interaction and/or lead fractures is
treated according to cause. In the interim, critical care
and emergency room nurses monitor cardiac rhythm, administer
antiarrhythmic medications, obtain a thorough history, recognize
battery function level, resuscitate per BCLS/ACLS protocol and
decrease patient/family fears. As advanced health care
practitioners, clinical nurse specialists via the clinical
expert, educator, research and consultant roles, are in a
excellent position to institute actions that will provide the
AICD patient competent, quality care.

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The Automatic Implantable Cardioverter Defibrillator

in Critical Care and Emergency Room Settings

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Seminar paper submitted to the Faculty

of the Graduate School of the University of Maryland

in partial fulfillment of the requirements for the

degree of Master of Science.

Running head: AICD

Table of Contents

Introduction

It is estimated that 450,000 to 700,000 annual deaths from cardiovascular diseases are sudden in nature (Schuster, 1990). Sudden cardiac death (SCD), the unexpected witnessed death of an apparently well person from cardiac dysfunction, occurs one every minute, making it the nation's number one killer (Featherstone, 1988). The majority of these sudden death episodes are due to malignant ventricular arrhythmias and, of those who experience such events, 20% to 30% survive (Cobb, Baum, Alvarez, & Schaffer, 1975). Numbers of those surviving SCD have been increasing due to the rapid response of emergency squads. Once recovered, these patients are confronted with the risk of fatal recurrence of the malignant arrhythmia and the possible resistance to antiarrhythmic medications. The clinician's assignment is to tailor available therapies to the individual's needs to meet the goal of prolonging survival.

A treatment modality developed within the last decade to promote patient survival is the Automatic Implantable Cardioverter Defibrillator (AICD). Because of the AICD's capability to detect and terminate malignant arrhythmias by administering an internal countershock, it is being lauded as the latest and most important intervention developed to

treat patients at high risk for SCD (Lee & Mirabel, 1989).

An in-depth exploration into the AICD is the purpose of this paper. The initial two chapters will discuss the AICD's sequential development, contributory factors to this development, device technology, and implant procedures. Likewise, in chapter three, problems leading to device malfunction and nursing actions applicable to promote patient recovery are addressed in article format. In February 1991, this article, "Identifying AICD Malfunction", was accepted for publication by Dimensions of Critical Care Nursing (DCCN). Finally, the last chapter will consider implications AICD technology places upon critical care and emergency room clinical nurse specialists.

Chapter 1

AICD's Impact

AICD therapy is the emerging "gold standard" for prophylaxis against fatal tachyarrhythmia recurrence (Lehman, Steinman, Schuger, & Jackson, 1988). Since 1985, 12,000 devices have been implanted and more implantations are expected to occur (Schuster, 1990). Impetus for this trend can be attributed to the frequency of recurring malignant ventricular arrhythmias, ineffective antiarrhythmic drug therapy, and the presence of inoperative cardiac disease.

Recurring malignant ventricular arrhythmias are the cause of concern in SCD. Many mechanisms can be potentially responsible for sudden death, but for the majority of these events, ventricular tachycardia (VT) and ventricular fibrillation (VF) are involved. Analysis of holter electrocardiographic recordings and programmed electrical stimulation reveals 45% to 61% of patients with sudden death show VF, frequently preceded by a period of sustained VT (Stevenson, Brugada. Waldecker, Zehender, & Wellens, 1985). Results of these studies suggest the recurrence of these life threatening arrhythmias during the post-resuscitative recovery period is the principle concern in the management

of these patients. Studies reveal a 30% one year and 40% two year mortality rate and an overall mortality of 60% at two years (Fonger et al., 1988).

Attempts to control of these recurring arrhythmias has focused on two therapeutic interventions. One intervention, the administration of antiarrhythmic medications, is initiated as the first line of defense to prevent recurring inducible arrhythmias (McCrum & Tyndall, 1988). The second intervention, surgical procedures, is completed to remove the effects of ischemic heart disease, the underlying etiology in the majority of sudden cardiac deaths (Fonger et al., 1988). Despite either intervention, SCD remains a major unresolved health problem due to the patient's unpredictable response to therapy.

Total suppression of recurring arrhythmias by antiarrhythmic medications is complicated by various factors. Full control of arrhythmias is only possible in 40% to 60% of patients with sustained arrhythmias due to poor compliance to medicinal regimens and the increased frequency of side effects with prolonged drug administration (DiMarco & Haines, 1990). As an example, Amiodarone, a previously widely used effective antiarrhythmic medication, is showing limited clinical utility due to its high

potential for toxicity. Serious side effects, such as pulmonary toxicity, are occurring within the therapeutic range of 1 to 2.5 mg/liter (Manolis, Tordjman, Mack, & Estes, 1987; Manolis, Uricchio, & Estes, 1989).

Likewise, uncomplicated usage of antiarrhythmic medications does not promise complete protection. Data reveal that despite pharmacologic intervention, SCD continues at a rate of 5% to 12% in the first year, with 20% to 40% dying by the fourth year (Lampert, Lown, Graboys, Podrid, & Blatt, 1988). Through research, Cobb and associates found nearly two thirds of the patients experiencing recurrent ventricular fibrillation were receiving antiarrhythmic therapy at the time of a second cardiac arrest (Cobb et al., 1975).

In addition to ineffective drug therapy, surgical interventions have shown minimal success in the treatment of recurrent arrhythmias. Coronary revascularization is completed on 20% of patients with SCD, with success dependent upon concomitant therapy (Troup, 1989). Despite these surgical attempts, current research findings reveal coronary revascularization followed by antiarrhythmic medications does not significantly reduce arrhythmia recurrence (Fonger et al., 1988). Similarly, studies

indicate that patients who receive subendocardial resections for VT continue to have a 20% recurrence rate of malignant arrhythmias (Miller, Kienzle, & Harken, 1984).

The presence of these recurring arrhythmias post surgery can be attributed to various mechanisms. Scars and aneurysms formed by previous myocardial infarctions, rarely respond to revascularization due to the extent of the original injury (DiMarco & Haines, 1990). Additionally, despite surgical intervention, ongoing changes in myocardial substrate caused by electrolyte or autonomic imbalances, leave the patient unprotected and still vulnerable to future tachyarrhythmic events (Akhtar, 1988).

Threats of arrhythmia recurrence in the presence of pharmacologic and/or operative interventions, have influenced AICD development. Review of data suggest that despite surgical interventions and conventional antiarrhythmic drug therapy approximately 20% of SCD survivors still remain vulnerable to life threatening arrhythmias (Troup, 1989). In response to this ongoing vulnerability, medical researchers developed the AICD.

AICD technology has evolved over an extended period. Beginning in the late 1960's, the concept of a fully implantable cardioverter defibrillator capable of

recognizing and treating ventricular arrhythmias required nearly 15 years of extensive animal research before the first cardioverter was implanted in humans. Pioneers in this research were Michael Mirowski, MD and collegues at Sinai Hospital, Baltimore, Maryland.

Dr. Mirowski, through canine experiments, identified basic principles fundamental to the operation of the AICD. It was proven that the amount of electrical energy required for direct epicardial defibrillation was much less than previously postulated for an intravascular electrode catheter system (Troup, 1989). Secondly, Dr. Mirowski demonstrated that to restore sinus rhythm a critical cell mass required depolarization, not the entire heart (Mirowski, Reid, Watkins, Weisfeldt, & Mower, 1981). From these findings, Dr. Mirowski hypothesized that a interconnected defibrillator and lead system could sense and convert malignant arrhythmias and deliver internal countershocks.

Fruition of Dr. Mirowski's labor came as device testing progressed. The first clinical prototypes of the Mirowski defibrillator was implanted in dogs in 1977 (Troup, 1989). Ultimately, from these canine studies, the first automatic implantable defibrillator evolved and, on February 4, 1980,

the first human implant occurred at Johns Hopkins Hospital, Baltimore, Maryland

The first generation automatic implantable defibrillator (AID) possessed a limited range of function. From 1980 to 1982, 57 devices were implanted and it's success was found to be minimal due to it's ability only to recognize and terminate ventricular fibrillation (Mirowski et al., 1983). The AID failed to properly detect rapid or slow ventricular tachycardias and was unable to count the true ventricular rate (Troup, 1989). Because of these deficiencies, the model was upgraded to provide a more comprehensive protection plan for SCD survivors.

With adjustments, the significantly improved second generation device, the AICD, contained an advanced sensing circuitry. Two sensing parameters, heart rate and probability density function (PDF), were added to improve malignant arrhythmia detection. The rate criterion compares the patient's heart rate to a preset cutoff rate and the PDF measures the amount of time the cardiac rhythm spends on the isoelectric line (Schuster, 1990). The significance of these parameters can be seen in the increased capacity of the AICD, versus the AID, to detect and treat potentially malignant but slower sustained ventricular tachyarrhythmias

found to initiate many episodes of SCD (Gabry et al., 1987).

With these improvements, the Food and Drug Administration

(FDA) approved the general use of the AICD in October, 1985

(Lee & Mirabel, 1989).

Since 1985, several AICD models, capable of different

functioning capacities, have been developed. The AICD

Ventak series, a third generation device manufactured by

Cardiac Pacemakers Incorporated, is functionally similar

to the second generation AICD but, due to it's relative

ease of production and smaller size, it is increasing in

popularity (Troup, 1989). Additionally, newer programmable

models, like the Ventak 1550 and the Ventak 1600

(under clinical investigation), allow for changes after

implant in the preset rate criterion, the turning "off" or

"on" of the PDF parameter, and the programming of the first

shock energy from 26 to 30 joules ("Your Programmable

Solution," 1989). Adjustments in joule therapy is

significant as antiarrhythmic medications are added or

reduced to control recurrent arrhythmias. Specifics on

device technology and possible drug interactions will be

further discussed in chapters 2 and 3, respectively.

Since it's initial use in the clinical setting, the

AICD has produced an enviable track record. Once a patient

receives an AICD system, the incidence of sudden death mortality is reduced to less than 2% in the first year and 13% by the fourth year (Lehman et al., 1988; Schuster, 1990). When treated solely with antiarrhythmic medication, clinical recurrence rate of arrhythmias can be as high as 50% in the first year raising mortality to 30% to 40% per year (Graboys, Lown, Podrid, & DeSilva, 1982; Higgins, 1990; Thurer, Luceri, & Bolooki, 1986). Likewise, a third alternative for treatment of malignant arrhythmias involves the combination of surgery, antiarrhythmics and AICD implantation. Research findings indicate that the AICD provides additional protection for these patients and augments their overall survival (Fonger et al., 1988).

Patient selection for this life saving device has followed specific criteria. For inclusion into the original AID study, patients must have survived two episodes of cardiac arrest with at least one episode of documented ventricular fibrillation while receiving antiarrhythmic therapy during one of the arrests (Mirowski, 1982). Present requirements have become less restrictive due to recent clinical investigation into the SCD phenomenon and the documented response of AICD models.

Based on documented success in the use of the AICD for

treating malignant arrhythmias, implant criteria have been revised. The FDA has approved the use of the AICD for two classifications of patients. First, those who have survived a sudden cardiac death episode resulting from hemodynamically unstable VT or VF not associated with acute myocardial infarction and secondly, those patients who, in the absence of previous arrest, have inducible ventricular arrhythmias despite conventional antiarrhythmic therapy (Schuster, 1990).

Along with FDA requirements, important physical factors are considered before device implantation. Physical factors restricting implant include the presence of concomitant disease states that limit survival to less than one year, the presence of a unipolar pacemaker, and the presence of ventricular arrhythmias caused by reversible or transient sources, such as electrolyte imbalances or hypoxia (Lee & Mirabel, 1989; Troup, 1989). Additionally, those who are expected to receive numerous shocks in a short time span also are not candidates since frequent shocks, caused by multiple episodes of sustained or nonsustained VT uncontrolled by drugs, can lead to device malfunction through battery depletion.

In conjunction with physical factors, psychological

health also is considered in evaluating a potential recipient. Psychological factors such as emotional maturity and stability promote patient selection. Additionally, a stable residency and the demonstration of a willingness and ability to cooperate in follow-up appointments are looked upon favorably.

To summarize, the AICD's development has been a continuous process. It's development is attributed to the increased incidence of SCD survivors, ineffective antiarrhythmic drug therapy and the patient's unpredicatble response to surgical interventions. Through canine experiments, Dr. Mirowski established the theoretical basis of AICD function and, from that point, human implantation and eventual FDA approval occurred. Due to the AICD's high success rate in treating recurrent fatal arrhythmias by delivering a countershock, the number of implantations are expected to increase. To meet this increase, advances in device technolggy continue at a quickened pace. Prevention of device misuse is promoted by maintaining a selective patient process. Criteria established by the FDA, in addition to the assessment of physical and psychological factors, must be fulfilled by patients prior to AICD implantation.

Chapter 2

Technological & Placement Review

Modes of treatment for primary ventricular arrhythmias are divided into prevention, cure or control. Prevention focuses on pharmacologic therapy, curative measures center on surgical procedures and control, the primary purpose of the AICD, focuses on restricting the disasterous consequences of tachycardia through prompt delivery of countershocks.

To provide countershock therapy, the AICD relies on two basic components. These components include the pulse generator and the lead system.

The first component, the pulse generator, contains the AICD's power sources. Located subcutaneously in the left upper abdominal quadrant, weighing 250g and measuring 11x7x2 cm, the pulse generator holds the electrical circuitry, capacitors and two lithium batteries (McCrum & Tyndall, 1988). Lithium vanadium pentoxide batteries provide basal monitoring current and bursts of high voltage currents, whereas capacitors store electrical energy (Troup, 1989). With this energy capability, the AICD has a monitoring life of three years or a discharge capability of 300 shocks ("Your Programmable Solution," 1989).

In conjunction with the pulse generator, the lead system, the second component of the AICD, consists of two pairs of electrodes that monitor heart rate and rhythm. One pair of electrodes, the ventricular patches or the shocking/morphology leads, are epicardial patches placed anteriorly and posteriorly on the heart surface to sense rhythm morphology and deliver shock therapy (Chapman, Veseth-Rogers, & Duquette, 1989; Schuster, 1990). Occasionally, instead of using a two ventricular patch configuration, a spring coil defibrillating electrode, positioned across the superior vena cava and right atrial junction, is placed in conjunction with only one ventricular patch (McCrum & Tyndall, 1988). The same defibrillating results are achieved. The second pair of electrodes, unipolar sutureless myocardial leads, are epicardial or endocardial screw-in electrodes placed in the right ventricular apex to count the heart rate (DeBorde, Aarons, & Biggs, 1991). Information gained from these two pairs of electrodes, the heart rate and rhythm morphology, aides in defining an arrhythmia and ultimately triggers AICD operation.

Before the AICD automatically delivers a countershock, information from the lead system on the heart rate and

rhythm morphology, must meet one of two criteria used to define an arrhythmia. The rate-only sensing parameter monitors and compares the patient's heart rate to a preset cutoff rate established preoperatively during stress testing. This cutoff rate, set at less than the patient's ventricular tachyarrhythmia rate and greater than the maximal sinus heart rate, triggers AICD firing when surpassed (Moser, Crawford, & thomas, 1988). For example, if the preset cutoff rate is 160 beats per minute (BPM) and the patient's heart rate exceeds 160 BPM, the device will deliver a countershock.

In addition to rate-only sensing parameters, the second sensing criteria used to define an arrhythmia is probability density functioning (PDF). PDF compares rhythm morphology to the amount of time spent on the baseline (Schuster, 1990). If the electrogram spends more time on the baseline, such as sinus rhythm, heart block or asystole, the PDF considers the rhythm normal. In contrast, if the electrogram spends little time on the baseline, for example VT or VF, PDF diagnoses the rhythm as abnormal.

Responsiveness of the AICD tͻ data received by PDF and rate parameters depends upon the type of AICD model implanted. In models utilizing the rate-only criteria,

only a heart rate over the preset rate is required to
institute shock therapy. Contrarily, in dual detection
devices, like the Ventak 1500, both rate and PDF parameters
must be satisfied before shocks are delivered (Schuster,
1990).

Once sensing criteria is satisfied, a specific amount
of time elapses between arrhythmia recognition, shock
generation and shock delivery. Within 10 to 35 seconds
after arrhythmia recognition, the AICD delivers its first
shock of 25 joules (McCrum & Tyndall, 1988; Schuster,
1990). Of those 35 seconds, 5 to 20 seconds are required to
diagnose the arrhythmia and an additional 5 to 15 seconds
are required for the pulse generator to charge its energy
storage capacitors and deliver a synchronized shock
(Schuster, 1990).

The arrhythmia's response to the initial shock guides
forthcoming AICD activity. A total of 5 shocks can be
delivered by newer AICD models in attempts to cardiovert.
Following the first shock, the AICD returns to monitoring
heart activity if the initial arrhythmia is successfully
cardioverted. Unsuccessful cardioversion triggers the
AICD to continue to deliver a maximum of 4 additional
shocks at 30 joules each ("Your Programmable Solution",

1989). After each shock, the rhythm is reassessed.
If after 4 shocks the arrhythmia continues, the AICD will
not reset to deliver another 4 or 5 shock sequence until
there is a 35 second period of normal cardiac rhythm
(Thomas, 1988).

Patients may or may not experience symptoms in
association with their arrhythmia and subsequent AICD
function. Awareness depends on the patient's level of
consciousness at the time of unit firing (Guzzetta, 1985).
Alert patients may feel palpitations, weakness, dizziness,
or lightheadedness prior to shock therapy, but after shock
delivery, they describe a general feeling of well being
(Moser et al., 1988). Most commonly, when felt, the shock is
described as a blow or kick to the chest (McCrum & Tyndall,
1988).

Preparation of the patient and family to device firing
is facilitated through education during the preoperative
period (Veseth-Rogers, 1990). The medical staff provides
information and answers questions so that both the patient
and family understands implantation procedures and device
function.

Additionally during the preoperative period, numerous
tests are completed to assess the patient's physical

condition. These preoperative tests include stress tests,

electrophysiologic studies,and cardiac catherization.

Stress tests and electrophysiologic studies are completed to

confirm the clinical arrhythmias that will determine the

cutoff rate and to evaluate the arrhythmia's response to

cardioversion-defibrillation (Rogers, 1986). Angiographic

studies assist in determining the need for concomitant

coronary artery bypass at the time of implant. Data

received from these tests aide the medical staff in

determining the full extent of cardiac disease and selecting

the appropriate operative approach.

Selection of the appropriate surgical approach is based

upon two criteria. First, the patient's history of chest

surgery is reviewed and secondly, the patient's need for

concurrent open heart repair is determined.

Depending on the findings of the above criteria, one of

four surgical approaches is selected to place the AICD lead

system. These approaches include the median sternotomy, the

lateral thoracotomy, the subxiphoid and subcostal

Each surgical approach is reserved for a specific

patient population. Subxiphoid and subcostal approaches are

reserved for patient populations not requiring additional

open heart procedures, whereas the median sternotomy is for

the patient who has never had chest surgery and requires

corrective open heart repair in conjunction with AICD

placement. The fourth approach, the lateral thoracotomy, is

used on AICD candidates who have had previous chest surgery

or when future cardiac surgery is anticipated (Watkins et

al., 1982). Whether of not corrective heart repair is done

in conjunction with AICD placement, any patient who has had

previous chest surgery and needs an AICD receives a lateral

thoracotomy. This is done to avoid the scar tissue

associated with previous chest surgeries which may interfere

with the surgical technique and the nealing process (Cooper,

Valladares, & Futterman, 1987).

In addition to specific patient populations, the

surgeon's preference also influences selection of the

surgical approach. Of the four surgical approaches, the

left lateral thoracotomy is the method preferred by surgeons

to enter the chest (Troup, 1989). Preference for this

technique is attributed to the improved visualization of

the left ventricle during lead placement (Olinger, Chapman,

Troup, & Almassi, 1988).

In association with it's frequent use, a high number of

postoperative complications occur with left lateral

thoracotomies. Following the review of the different

surgical approaches, research has shown that of those patients receiving a left lateral thracotomy procedure, 26% have an increased chance of developing pulmonary complications in contrast to those patients receiving subxiphoid, subcostal or median sternotomy operations (Kelly et al., 1988).

Because of increased complications associated with left lateral thoracotomies, new surgical approaches are being perfected (Manolis, Rastigar, & Estes, 1989). Presently, a fully transvenous lead system is being clinically tested which, if fully successful, will allow for AICD implantation without thoracotomy risks (Saksena & Parsonnet, 1988).

Until the transvenous approach is mastered, thoracic approaches will continue to focus on lead system placement. During surgery, the two ventricular defibrillating patch leads are sutured to the fibrous pericardium. One patch is placed over the apex of the left ventricle and the other patch is placed over the right atrium or right ventricle. The two unipolar sutureless leads are screwed into the anterior portion of the right ventricle (Lee & Mirabel, 1989).

Once the lead system is placed, implantation of the pulse generator follows. The placement technique for the

pulse generator is the same for all surgical approaches. It involves development of a subcutaneous pocket in the left para-umbilical area just anterior to the abdominal fascia (McCrum & Tyndall, 1988).

After implantation of the pulse generator and the lead system, connection of the two AICD components is attempted. Using a tunneler, the free ends of the lead system electrodes are passed subcutaneously into the pocket containing the pulse generator and connected to their respective ports.

Following this internal connection and prior to thoracic closure, intraoperative tests are performed to evaluate AICD function. Intraoperative tests conducted involve determining the defibrillation threshold and evaluating shock delivery and effectiveness.

Testing of the defibrillation threshold yields vital information on energy requirements needed for successful cardioversion. The defibrillation threshold, the minimum energy required to terminate VT or VF without failure, is determined by externally defibrillating an intra-operatively induced ventricular arrhythmia (Cannom & Winkle, 1986; Manolis et al., 1988). The lower the threshold, the less the amount of energy required to

cardiovert whereas a high threshold reveals the need for high energy output for arrhythmia termination.

Findings cf a high or low defibrillation threshold are used to determine AICD activity for the immediate postoperative period. A defibrillation threshold of less than 20 joules is ideal for a standard device which holds an energy output of 25 to 32 joules (Marchlinski, Flores, Miller, Gottlieb, & Hargrove, 1988). When this occurs, the AICD can remain activated postoperatively. For defibrillation thresholds greater than 20 joules, AICD activation is delayed until the cause of the increased energy requirement is determined (Lee & Mirabel, 1989).

Increases in defibrillation thresholds can be attributed to various factors. Hypokalemia, amiodarone therapy and the administration of lidocaine have been identified as causing elevations in defibrillation thresholds whereas age, gender, or cardiac diagnosis have shown no significant effect (Guarnieri et al., 1987; Kelly et al., 1988; Mirowski, 1985).

Once defibrillation thresholds are clarified to be below 20 joules, intraopertive testing proceeds to evaluating the AICD's shock delivery and its subsequent effectiveness. To assess AICD capabilities, the malignant

arrhythmia is again induced but, instead of using the external defibrillator, the surgical team awaits the AICD's response and observes the results of shock delivery.

The intraoperative testing of the AICD elicits one of two responses from the surgical team. First, if the device fails to fire or the energy delivered is inadequate to cardiovert, the surgical team will proceed to identify and correct the cause. Secondly, and foremost, if the cardioversion is successful, the surgery concludes, incisions are closed, and the AICD may continue operational for the immediate postoperative period.

During the postoperative period, the majority of care for the AICD patient is similar to care given any cardiac surgical patient. The patient recovers in the coronary care unit or on an open heart special intensive care unit (SICU) if bypass surgery was done. In either environment, the heart rhythm is closely monitored for arrhythmias and the AICD is observed for its cardioversion effectiveness. Concurrently, in addition to monitoring heart rhythms, pulmonary artery pressures, blood pressures, electrolyte levels, arterial blood gases and urine outputs are assessed frequently for signs of hemodynamic compromise.

Likewise, because of the nature of the surgical

procedure and the underlying malignant arrhythmia, special postoperative considerations do exist. Initially, the nurse ascertains whether the AICD is in an "active" or "inactive" mode so appropriate resuscitative protocols can be instituted during tacharrhythmic events (Cooper, Valladares, & Futterman, 1987). The device may be inactive immediately post surgery because of the potential for frequent ventricular arrhythmias from heart irritability produced from surgical manipulation or due to elevated defibrillation thresholds. If the device is inactive, routine emergency procedures are implemented with symptomatic VT or VF, whereas an active AICD leaves the nurse to assess appropriate AICD function. Additionally, due to the presence of the underlying malignant arrhythmia, antiarrhythmic drug therapy is managed closely to prevent recurrent arrhythmia episodes and the subsequent frequent firing of the AICD.

In congruence with this continuous myocardial and device assessment, postimplant tests are completed during the postoperative period. Periodic chest x-rays are required to evaluate lead position and device system integrity (Cooper et al., 1987). Electrophysiologic studies, done initially preoperatively, are repeated

postoperatively to assure the medical team the device will terminate the arrhythmia and to allow the patient to experience a shock while alert.

Concurrently, postimplant exercise tolerance tests are done postoperatively to provide additional useful clinical information. Information gained from the exercise tests include identification of exercise induced arrhythmias, effectiveness or ineffectiveness of antiarrhythmic drug therapy and the patient's exercise tolerance. Summation of these findings aid in the development of an exercise plan to be used by the patient to guide activity after hospital discharge.

Upon discharge, follow-up visits are scheduled at specific intervals. Because no adequate method has been determined to accurately predict device longevity, each patient must maintain follow-up visits to ascertain if the device is operating properly (Troup, 1989). Follow-up evaluation of the AICD is required every two months, or more frequently if needed, for the first 12 months. After the first year, AICD evaluation occurs every month (Higgins, 1990).

During these follow-up visits, assessment of AICD

activity for non-programmable models is accomplished by completing two tests. These two tests involve the use of a ring shaped magnet and the AIDCHECK probe.

Magnet tests aid in clarifying whether the AICD is "on" or "off". Anytime a magnet is within four inches of the pulse generator, audible tones are emitted (Chapman et al., 1989). A magnet placed on an active generator will produce beeps synchronous to the QRS complex, whereas a continuous tone signifies deactivation.

Care is taken not to leave the magnet over the generator for long periods of time. If left in place for greater than 30 seconds, an active pulse generator can be inadvertently rendered inactive. Likewise, if left in place for at least two seconds but less than 30 seconds, the magnet will cause an active device to generate a spontaneous shock that is not directly harmful to the patient, but wasteful of energy stores (Chapman et al., 1989).

In conjunction with the magnet test, the AIDCHECK probe provides additional useful information on the AICD's battery status. With the magnet in place over the right corner of the AICD, the AIDCHECK probe, placed in the upper left corner, reveals the time in seconds that the capacitors take to form a shock and displays the number of times

shock therapy has been delivered since the patient's last follow-up visit (Chapman et al., 1989; Schuster, 1990).

Based on the results of magnet and AIDCHECK tests elective replacement criteria for non-programmable pulse generators have been established. It is recommended that an increase of greater than one second recorded between two consecutive magnet tests during a single follow-up examination may imply impending failure and warrant generator replacement (Gabry et al., 1987).

Testing of programmable models utilizes a different instrument but similar information is gained. Instead of using the magnet and AIDCHECK probe, a hand held programmer with telemetry communication is placed over the AICD to yield information on the number of shocks used to treat a single dysrhythmia, the condition of the shocking leads, and battery status (Schuster, 1990; "Your Programmable Solution", 1989).

In concert with device testing, follow-up visits also entail supplementary physical assessments. A brief, verbal history of what has occurred between visits is obtained, an electrocardiographic tracing is recorded and a physical examination is completed.

In addition to the physical assessment, the patient's psychological well-being is evaluated during follow-up visits. The patient and family are encouraged to ask questions and voice concerns, aiding the nurse's assessment of the patient's and family's adjustment to the device.

The psychological impact following device implantation produces a wide range of feelings in both the patient and family members. Anxiety and depression regarding their illness and their inability to return to a functional lifestyle are a common result (Cooper et al., 1989). Fear of death and anxiousness over device function is promulgated because of the patient's sense of not being cured but rather having incurred a life long dependency on a machine. Finally, as a result of their uncertain prognosis and feelings of impending mortality, a sense of powerlessness, anger and frustration can overwhelm the AICD recipient (Teplitz, Egenes, & Brask, 1990).

Because of these feelings, the AICD patient and his/her family have a great need for supportive nursing interventions. One intervention effective in reducing anxiety and facilitating adjustment to illness is the use of support groups (Teplitz et al., 1990). In this

environment, trust, acceptance, and mutual support is fostered as individuals interact with people encountering the same feelings and difficulties.

Summation of this chapter provides recognition of important aspects of AICD technology, patient preparation and the ongoing assessment of both. Through a dual lead system, data are obtained on rhythm morphology and heart rate and, with energy from the pulse generator, the AICD delivers a shock 'n cardiovert the life threatening arrhythmia. 'c assure successful cardioversion, system implantation, via one of four surgical approaches, involves intraoperative testing of defibrillation thresholds and AICD effectiveness. Surveillance of AICD activity, along with patient response, continues throughout the postoperative period within a monitored setting. During hospitalization, patient awareness of device technology, testing procedures and follow-up examination requirements is promoted to prepare the AICD recipient for future tachyarrhythmic events and to assess the patient's acceptance of the device. Because of the psychological impact from device implantation, ongoing support from peers and family is needed by AICD patients to effect a positive recovery.

Chapter 3

Identifying AICD Malfunction

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The Automatic Implantable Cardioverter Defibrillator

(AICD) is an implanted device designed to continuously

monitor heart activity and in response to ventricular

tachycardia (VT) or ventricular fibrillation (VF), deliver

countershocks. Since it's approval five years ago by the

Food and Drug Administration, over 12,000 devices have been

implanted (Schuster, 1990). It's ability to successfully

decrease the incidence of sudden cardiac death has been

widely documented in the literature, but its drawbacks

require further examination.

As the AICD patient population grows, the critical care

and emergency room nurse will encounter emergency situations

requiring unique assessment and management skills. The

emergency room nurse will see patients, who have no outward

signs of having an AICD, complaining anxiously of feeling

blows to the chest. The critical care nurse will see

changes in hemodynamic parameters as the AICD fails to

respond properly to tachyarrhythmic events. This article

describes the potential problems of the AICD that may

result in the need for emergency interventions and subsequent nursing actions paramount for patient recovery

<u>AICD Normal Function</u>

Several AICD models are being implanted; the most recent having programmable capabilities. Despite different detection criteria and energy capabilities, standard factors effect the function of all AICD units.

Implanted surgically, the AICD consists of a pulse generator and two lead-sensing systems. The pulse generator, comprised of electronic components and two lithium batteries, is responsible for shock generation. The two lead systems, rate-only or rate with probability density function, are responsible for monitoring heart rhythm and shock delivery. The probability density function monitors activity on the isoelectric line. Rhythms remaining on the isoelectric line are considered normal, whereas rhythms spending minimal time on the line, such as VT or VF, are evaluated as abnormal.

Criteria for device activation depends on the AICD model. Rate-only models are triggered by heart rates exceeding the preset cutoff rate, whereas the dual detection model requires both rate and morphology parameters be met before shock therapy is initiated. Once parameters are met

the first shock will occur in 10 to 30 seconds (Lee &
Mirabel, 1989). After the initial shock, a maximum of
four additional shocks can be delivered in attempts to
cardiovert, after which, if the device does not see 35
seconds of a rhythm other than VT or VF, it will not deliver
any further therapy ("Your Programmable Solution", 1989).

Problems Causing Device Malfunction

The inability of the AICD to effectively deliver shocks
to the myocardium is a major problem in device malfunction.
Device malfunction is a concern for both the patient and
nurse because the underlying arrhythmia responsible for the
implant is life threatening. The primary cardiac rhythm
disturbances requiring device implantation are VT (36%), VF
(18%) and both VT and VF (34%) (Troup, 1989).

The goal of the AICD is treatment of these life
threatening arrhythmias by shock delivery after the
arrhythmia. This is a different approach than medication
treatment which has the goal of preventing arrhythmias
and/or slows the rate making the arrhythmia more amenable to
shock. Concomitant drug therapy can be used with the AICD.
Despite this combination of mechanical and pharmacologic
therapy, concern over device malfunction remains an issue.

Drug therapy decreases but does not abolish the

recurrence of ventricular arrhythmias (Bower, Freeman, Rickards, & Rowland, 1989). Of those patients receiving antiarrhythmic drug therapy, 50% continue to have episodes of VT or VF despite the medication (Higgins, 1990). Development of break through episodes of malignant arrhythmias coupled with device malfunction can leave the patient prone to sudden cardiac death.

Due to the threat of sudden cardiac death, identification of problems that can effect AICD function require attention. The presence of infection, delivery of inappropriate shocks, development of battery failure, pacemaker interaction, drug interaction, lead migration, and undersensing are examples of problems that can lead to AICD malfunction and, its subsequent inability to respond effectively in life threatening situations.

Infection

Infection is an infrequent cause of device malfunction. When present, malfunction is attributed to alterations in the AICD's system integrity. Staphylococcus epidermidis and staphylococcus aureus are the primary infectious agents (Almassi, Olinger, Troup, Chapman, & Goodman, 1988; Winkle et al., 1989). The development of abdominal-pocket infections occur in 2% of patients

although delayed infections have been documented 7 to 31 months after implantation (Almassi et al., 1988). Isolation of the infection to the generator pocket is seldom seen due to the direct continuity of the pocket with the electrode system (Troup, 1989).

The majority of patients with abdominal-pocket infections do not exhibit fever, leukocytosis, or sepsis. However, they exhibit specific clinical signs such as erythema, discoloration, and tenderness over the leads and pulse generator (Goodman et al., 1989). Treatment, dependent on infection severity and device integrity, ranges from explantation to antibiotic therapy.

Preliminary data suggest that infectious processes can cause distortion or crumbling of the AICD defibrillating patches necessitating increases in energy thresholds for effective defibrillation (Goodman et al., 1989). Because of these changes in energy thresholds, the AICD's ability to successfully cardiovert during and after the infectious process is questionable.

Inappropriate Shock Delivery

False positive discharges or inappropriate shocks occur in up to 40% to 50% of patients (Manolis et al., 1989). Data for 5,514 AICD recipients showed the average number of

spontaneous shocks was 6.3 shocks per patient (Troup, 1989).
Self terminating ventricular tachycardias, pacemaker
interaction, lead fractures and the faulty sensing of
supra-ventricular tachycardias are potential triggering
stimuli (Chapman et al., 1989; Troup, 1989). Treatment
protocols range from surgical replacement of fractured leads
to review of medicinal regimens.

Although inappropriate pulses have rarely been
documented to result in malignant dysrhythmias, the
resulting physical and emotional discomfort felt by the
patient due to this functional error warrants concern.
Unless the inappropriate shock delivery is halted, the
device's longevity and the patient's safety are threatened.

Battery Depletion

Inability of the AICD to generate countershocks because
of battery depletion is a deadly malfunction that leaves the
patient unprotected from the life threatening arrhythmia.
The life of the AICD battery ranges from 100 to 300 shocks
at 26 to 30 joules ("Your Programmable Solution", 1989). A
battery is depleted when the length of time and/or device
use has exceeded battery life (Valladares & Lemberg, 1987).
An example of excessive device use often occurs with sinus
tachycardia. Occurring with increased activity or as a

result of catecholamine release during the stress response, sinus tachycardia continually triggers the AICD and thus depletes battery stores. The battery may be depleted prior to the expected battery life of 18 to 30 months for non-programmable models and 4 to 5 years for programmable devices (Schuster, 1990).

Premature battery depletion occurs in 3% to 17% of implanted devices (Manolis et al., 1989). Patients who exhibit poor adherence to drug regimen or experience an increase in activity or stress levels have more arrhythmias and thus use up more shocks and deplete the battery faster than more compliant patients. In addition, patients who fail to maintain magnet and AIDCHECK tests, non-invasive follow-up examinations used to evaluate and recharge energy storage capacitors, are also at risk for premature battery depletion.

Battery Deactivation

Device failure also occurs due to battery deactivation. Incidental battery deactivation can occur when patients come in contact with magnetic interferences from heavy machinery, airport wands, and MRI testing units (Higgins, 1990). If the patient is not removed from this magnetic field, the AICD is placed in the "inactive" mode rendering the pulse

generator unresponsive to dysrhythmias.

Pacemaker Interaction

Some patients have both an AICD and a permanent pacemaker. When used in combination to treat life threatening arrhythmias, interactions between devices influence the AICD's functioning capability.

Pacemaker-defibrillator interactions involve double counting and detection inhibition. Double counting, the counting of both pacer impulse and evoked ventricular depolarization, causes unnecessary defibrillation discharges during paced rhythm due to surpassing AICD rate requirements (Thurer et al., 1986). Detection inhibition occurs when the AICD bases its arrhythmia analysis on pacemaker artifact rather than VT or VF (DeBorde, Aarons, & Biggs, 1991). The AICD overlooks the fatal arrhythmia, thus no shock therapy is delivered.

Undersensing

Successful cardioversion of arrhythmias is partially dependent upon the AICD's ability to sense the true cardiac rhythm. Undersensing, the misreading of arrhythmias by the AICD, is attributed to VT being slower than the cutoff rate, morphology criteria not being satisfied and/or malfunction within the AICD's lead system (Chapman et al., 1989).

Because of this incorrect sensing by the AICD, the

life threatening arrhythmia continues and, without external

defibrillation, the patient progresses to unconsciousness

and cardiac arrest.

Lead Migration and Lead Fracture

Changes in the lead system by lead migration and lead

fracture also affects AICD function. Spring lead migration

occurs in 3% of cases (Troup, 1989). When the spring

shocking electrode displaces from its normal position,

abnormal sensing results and the AICD becomes ineffective in

its ability to cardiovert (Chapman et al., 1989). Lead

fractures, present in 2% of AICD recipients, result in

inappropriate shocks for heart rates less than the device

cutoff rate (Winkle, Stinson, Echt, Mead, & Schmidt, 1984).

Continuation of these inappropriate shocks lead to AICD

malfunction because of battery depletion.

Drug Interactions

The combination of antiarrhythmic drug therapy with the

AICD effects device function in two ways. First, certain

drugs such as Amiodarone and Encainide, increase energy

requirements for defibrillation (Fain, Dorian, Davy, Kates,

& Winkle, 1986; Kelly et al., 1988). Due to the

defibrillator's capacity to deliver limited amounts of

energy, the raising of the defibrillation threshold by these medications renders the AICD unable to successfully cardiovert. Secondly, by slowing the rate of ventricular tachyarrhythmias through the use of multiple drugs, arrhythmia detection by the AICD is missed, leaving the patient vulnerable to sudden cardiac death (Chapman et al., 1989).

Nursing Interventions

In order to prevent emergencies from developing, the critical care and emergency room nurse's response to battery failure, infection, inappropriate shock delivery, lead migration, pacemaker interaction and drug interaction is to provide for the patient a monitored, secure environment. In conjunction with this action, nursing procedures focusing on differentiating cardiac dysfunction from AICD malfunction are completed to effect a positive patient outcome.

Monitor Cardiac Function

The critical care or emergency room nurse first monitors cardiac function. As a form of protection for the patient who has a malfunctioning AICD unit due to infection, battery failure or drug interaction, continuous electrocardiograph (ECG) monitoring affords prompt recognition of life threatening arrhythmias and prompt

initiation of emergency interventions. Twelve lead

electrocardiograms aid in assessing myocardial status, not

AICD activity. Only during shock delivery, not during

charging or sensing, is AICD function visible on the

electrocardiogram (Schuster, 1990).

If inappropriate pulsations are the problem, cardiac

monitoring enables the critical care or emergency room

nurse to document what type of cardiac rhythm is present

during shock delivery. By documenting episodes of

ventricular tachycardia or non-target arrhythmias, such as

atrial fibrillation or sinus tachycardia, the critical care

or emergency room nurse discerns whether the AICD is

functioning appropriately or the medicinal regimen is

inadequate. If the AICD does fire, the electrocardiogram

tracing will move off the baseline as the AICD shock

overwhelms the ECG amplifiers (Schuster, 1990).

The nurse also reviews results of arterial blood gases,

serum potassium, serum magnesium, drug levels and cardiac

enzymes to further assess cardiac status. Electrolyte

imbalances, drug toxicity, and hypoxia precipitate arrhythmias.

Hypokalemia and Amiodarone levels greater than 2.5 mg/liter

promote AICD malfunction by elevating defibrillation

thresholds (Manolis, Rastegar, Estes, 1989; Manolis,

Uricchio, Estes, 1989).

Administer Antiarrhythmic Medications

Antiarrhythmic drug therapy continues for 67% of AICD patients following implantation (Cardiac Pacemakers Incorporated, 1988). While the AICD function is being assessed the nurse continues to administer antiarrhythmic medications within the monitored setting with the goal of preventing the recurrence of the life threatening arrhythmia.

Patients with functioning AICD units receive medications to suppress recurrent tachyarrhythmias. These tachyarrhythmias are responsible for triggering AICD discharges frequently and causing battery failure. Examples of drugs capable of decreasing tachyarrhythmias are Amiodarone and beta blockers. Amiodarone in small doses reduces episodes of sustained/nonsustained VT whereas beta blockade therapy prevents inappropriate shocks from sinus tachycardia by decreasing the heart rate below the preset cutoff rate (Kelly et al., 1988).

Problems leading to device malfunction guides the administration of antiarrhythmic medications in patients with inoperable units. Patients with inoperable devices due to infection, lead migration and battery failure rely solely on drug therapy for treatment of arrhythmias until

device replacement occurs, whereas drugs causing device malfunction due to toxic levels are discontinued and medicinal regimens are adjusted in a monitored setting (Chapman et al., 1989).

Obtain a Thorough History

When a patient is suspected of having problems associated with AICD function, the nurse completes a brief description of the chief complaint and a cardiac history. Due to the absence of memory capability within the AICD, the nurse asks the patient about AICD activity. The complete history includes information on:

--absence or presence of symptoms like lightheadedness, palpitations, chest pain or shortness of breath.

--signs of infection including erythema, drainage, swelling or tenderness over pulse generator or leads

--activity at the time of shock delivery for example climbing stairs, housework, walking, sitting or exercising.

--recent changes in activity level such as the starting of a new exercise regimen or vacation/tourist activity.

--recent stressful events like a family death or job/economic strain.

--adherence to medication schedule including last dose taken and any side effects experienced.

--adherence to follow-up appointments with results of follow-up tests and diary notations.

Review diaries or notebooks kept by the patient or family member. After initial implant, these patients are instructed to maintain a diary describing symptoms and related activities accompanying each shock (Cooper et al., 1987). This diary review provides the critical care or emergency room nurse a broader perspective into the patient's condition and device history.

Potentially confounding this assessment is the subjective nature of each patient's experience associated with device discharge and the invariable excitement and sometimes confusion that follows (Troup, 1989). To clarify the patient's oral and written reports, collect objective data on the device's current functioning mode, the battery status and the number of actual shocks delivered by completing the magnet and AIDCHECK tests.

Recognize Battery Function Level

The critical care or emergency room nurse assists the physician in completing tests to assess battery status. Non-invasive system analysis of the operational status of the AICD is accomplished to determine its ability to successfully cardiovert future arrhythmic events.

A doughnut shaped magnet aides in assessing the functional mode of the AICD. By placing the magnet over the right upper corner of the pulse generator, pulsating tones synchronous to the QRS complex are emitted to indicate an active mode. Absence of tones suggest AICD malfunction or impending battery depletion (Craig, 1990).

To further assess battery status, the magnet is used in conjunction with the AIDCHECK probe. The physician or electrophysiology nurse places the AIDCHECK probe over the left corner of the pulse generator and the magnet over the right corner of the pulse generator. The AIDCHECK probe detects radio frequency signals emitted by the AICD device and, from these signals, determines the number of shocks delivered and the remaining battery capacity (Thomas, 1990). For patient safety, ECG monitoring is maintained and emergency equipment is available since the interrogation process may result in a misdirected charge to the patient.

The critical care or emergency room nurse's response to arrhythmias depends upon the AICD's operational status. If the AICD is operational, observe rhythm response as well as patient response to shock delivery and intervene immediately if the patient has ventricular arrhythmias below the device cutoff rate or if the life threatening

arrhythmia is not terminated within the four or five shock

sequence. If the AICD is inoperative due to battery

depletion or malfunction, emergency interventions to treat

life threatening arrhythmias include external cardioversion

as described in the next section.

Resuscitate per BCLS/ACLS Protocol

In the event a patient with an AICD becomes

hemodynamically unstable due to VT or VF or suffers a

cardiac arrest, the critical care or emergency room nurse

performs emergency resuscitative procedures as if the AICD

does not exist. The patient's survival, not concern for the

AICD, is the priority. Basic and advanced cardiac life

support protocols can be completed according to unit policy

without fear of damaging the AICD, although two adjustments

to those treatment protocols may be required.

First, the nurse or physician may rotate the paddle

positions if the first shock is unsuccessful. The internal

titanium mesh defibrillator patches comprising the

defibrillating lead system contain a silastic backing that

not only acts as an insulator but, also can deflect the

defibrillating current coming from external paddles (Walls,

Schuder, Curtis, Stephenson, McDaniel, & Flaker, 1989).

Adjustment of paddle placement to anterior-posterior

or anterolateral can overcome this impasse (see Appendixes A and B for diagrams).

Secondly, all health professionals should wear gloves during the resuscitation process to reduce shock potential to the rescuer. If after external defibrillation, the patient develops transient conversion to asystole, bradycardia, atrioventricular or idioventricular rhythm for at least 35 seconds, the "active" AICD recycles to deliver another 4 or 5 shock sequence (Valladares & Lemberg, 1987). If the AICD discharges while the rescuer has his or her hands on the victim's chest, the shock is perceptible and possibly painful, but not dangerous to the rescuer (American Heart Association, 1987). The wearing of rubber examination gloves can insulate the rescuer from this energy release.

Decrease Patient/Family Fears

The nurse helps these patient to reduce their fears. The patient with an AICD experiences fear of death. Previous experiences with sudden cardiac death, myocardial infarctions, long hospitalizations and numerous tests often leave the patients feeling out of control, inadequate, and defenseless. Psychologically regressive behavior can occur as a result of illness, hospitalization, bed rest or restrictive or unpleasant therapeutic regimens (Corradi,

1983).

To help the patient overcome these feelings of despair, encourage the patient to verbalize fears and concerns. Because anxiety and fear may block the patient's perception of the event and educational information, reinforce previously given information on a frequent basis. Integrate the family into patient care to build tru t and promote communication.

Case Example

Mr. T, a 45 year old white male, was admitted through the emergency room to the coronary care unit (CCU) following complaints of receiving several shocks over a 6 hour period. The AICD was implanted 4 months earlier due to the patient experiencing a spontaneous cardiac arrest. Preliminary assessment revealed a slightly obese male, non-smoker, with a familial history of cardiomyopathy. Medication therapy consisted of quinidine. Vital signs were 130/80 blood pressure, 88 apical pulse, 18 respirations, and 98.8 temperature. The electrocardiogram completed in the emergency room showed no acute changes, thus the patient was admitted for device evaluation.

Immediately upon CCU admission, the nurse placed Mr. T on cardiac monitor, after which a shock was documented

during normal sinus rhythm. Lab work obtained included drug

levels, electrolytes and cardiac enzymes. The physical exam

was unremarkable; the lungs were clear, jugular vein

distention absent, and heart sounds normal. The abdominal

exam was negative with the AICD generator visible in the

left upper quadrant without redness, drainage or tenderness.

During the physical assessment, the nurse asked the

patient questions to clarify events surrounding device

firing. No change in activity levels were reported prior to

shock delivery. Mr. T denied shortness of breath, chest

pain, palpitations or lightheadedness. Medication therapy

was maintained and diary notations revealed continuity of

follow-up visits with non-invasive test results.

The physician performed magnet and AIDCHECK tests to

clarify subjective data. These tests showed the patient had

received 5 shocks within the last 24 hours and the battery

level adequate. Also, drug levels, electrolytes and

cardiac enzymes returned within normal ranges. Because of

these results, a chest x-ray was obtained to evaluate the

lead system and, upon review of the films, a lead fracture

was diagnosed. It was felt that the fractured lead sensed

skeletal-induced myopotentials, resulting in shock delivery

during normal sinus rhythm. Because of these inappropriate

shocks caused by the lead fracture, the physician

inactivated the AICD until lead replacement occurred. This

was done to prevent further wasting of battery stores.

Between lead replacements, nurses maintained a safe,

secure environment for the patient. Electrocardiographic

monitoring continued, an intravenous line was placed

for emergency access, quinidine continued to be

administered, and resuscitative equipment was kept

in close approximation.

Despite these procedures, Mr. T was very fearful.

Because of a previous sudden cardiac death experience and

due to feeling unprotected after device inactivation, Mr.T

expressed fears of death. Nurses allayed these fears by

letting him voice his concerns and by showing Mr. T his

heart was continuously being monitored. A supportive

environment was further fostered by allowing family members

to visit the patient frequently and by involving them in

educaton sessions.

Lead replacement occurred within 24 hours following

admission. The AICD was reactivated during surgery to

assure lead function and it remained active throughout the

postoperative period. After lead replacement, no

inappropriate shocks were documented in the monitored

setting and, to assure arrhythmia control, a post stress test was completed confirming medication and AICD efficacy. Four days after admission, the patient was discharged and permitted to return to a full range of activities.

"The name and non-essential characteristics of this case have been changed for confidentiality. Any similarity to actual persons is coincidental".

Conclusion

There is little question that the AICD is an effective treatment of patients with sustained VT or VF, but as newer complex units are released, the frequency of defects may increase (DiMarco & Haines, 1989). Because of this, additional demands will be placed upon critical care and emergency room nurses to speedily assess and treat problems that lead to AICD malfunction and, subsequent sudden cardiac death.

Chapter 4

Implications for Advanced Nursing Practice

Sudden Cardiac Death is one of this nation's leading killers. In response to this occurrence, the AICD was developed and it continues to progress in technological complexity in efforts to protect patients. The emergency room and critical care clinical nurse specialists occupy pivotal roles in assuring competent, safe clinical practice as AICD technology advances. Through the sub-roles of clinical expert, educator, researcher and consultant, the clinical nurse specialist (CNS) can become instrumental in facilitating efficient health care delivery to AICD patients.

Clinical Expert

The CNS serves as a role model for advanced nursing practice (American Association of Critical Care Nurses, 1988). Revered as a clinical expert because of his/her advanced educational experience and his/her professional objectives, the CNS's main priority is the deliverance of quality patient care (Breiger, Smith & Muenchau, 1989). Many reasons exist for this focus, the foremost being the advancement of nursing practice

(Koetters, 1989).

As a master clinician, the CNS is able to identify clinical problems that could impede delivery of quality patient care. With the AICD patient, potential clinical difficulties arise from improper resuscitation techniques and incomplete assessment of device function. Errors made in either area are life threatening to AICD patients. In addressing these problems, the CNS's goal is to develop and implement protocols or innovations in attempts to alleviate difficulties before they occur.

The development, implementation, and evaluation of standards of care for practice are important components of the CNS's clinical expert role (American Association of Critical Care Nurses, 1988). By outlining AICD assessment procedures such as magnet testing and resuscitative steps like paddle placement adjustment for defibrillation in unit policies and procedure manuals, a point of reference can be readily available at all times for emergency room and critical care nurses. Otherwise, the CNS works beside the nursing staff, aiding in diagnostic interpretation and treatment demands in accordance with these unit

policies. Completion of these actions exemplifies the CNS's progressive and skillful clinical practice.

The CNS evaluates these standards of care by completing quality assurance activities. Once data are gathered and analyzed, results are screened for trends and problems are identified. The CNS utilizes these results to update policies and/or to make recommendations to improve care given to the AICD patient.

Revisions of these standards of care will be ongoing as AICD technology advances and the patient population extends into other disciplines. In specialty areas such as flight nursing, the Air Force clinical nurse specialist may find it necessary to adjust protocols as the number of patient transports increase. Examples of these types of revisions, which would be adopted from quality assurance audits and research based findings, may include the need for sea level altitude restrictions to prevent effects of hypoxemia, the continuous delivery of oxygen therapy and the maintaining of electrocardiographic monitoring throughout the flight. Presently, no restrictions apply to air transport of the AICD patient.

Educator

The nurse practicing in the critical care or
emergency room setting has to keep abreast of current
knowledge about numerous sub-specialties as well as
trends in recommended changes that could affect nursing
care. The CNS assists critical care and emergency
room nursing staffs in the acquisition of practice
skills and new knowledge (American Association of
Critical Care Nurses, 1988)

There are several areas in which emergency room
nurses require education concerning the AICD patient.
The instructional areas to be covered include the
use of magnet and AIDCHECK devices to assess device
function, the recognition of the significance of continuous
electrocardiographic monitoring in guiding patient
treatment, the awareness of the psychological impact
felt by the patient following device firing, and the
acknowledgement of changes in ACLS resuscitative protocols
to effect a positive patient outcome.

Likewise, critical care nurses also have learning
needs, primarily to be completed during unit
orientation. The incorporation of standards of care
for ACID patients into preceptor programs can promote

review of these policies at an early stage. This early

instruction of nurses, who are beginning their career

or starting a new position in the critical care

environment, is part of the facilitating component of

the CNS educator role where the CNS promotes the

acquisition of clinical knowledge and decision making

skills by nurses (American Association of Critical Care

Nurses, 1988).

Dissemination of this knowledge to emergency

room and critical care nurses by the CNS educator can

be accomplished by using different teaching strategies.

One innovative teaching strategy that can be prepared

by the CNS to meet both emergency room and critical care

nursing needs is a computer assisted instruction (CAI)

program. Present computer programs cover such topics

as blood gas analysis and advanced trauma life support.

The AICD CAI can comprehensively cover all areas

presented in this paper in a dynamic, interactive

fashion.

Use of CAI as a teaching strategy offers many

benefits to both the nursing staff and the CNS. The

CAI lesson is the master teacher, modifying

instruction depending on the learners response to

questions in the lesson (Billings, 1986). This method
of instruction allows for individualized, consistent
instruction, it is accessible to evening and night
shift nurses, it can be easily updated, and it can
decrease the classroom teaching time of the CNS,
freeing him/her to complete other educator role
responsibilities.

Publishing is another component of the CNS's
educator role. The CNS contributes to nursing
knowledge through scholarly publications and
presentations on clinical topics and issues in critical
care and emergency nursing (American Association of
Critical Care Nurses, 1988). Because of continual
technological advances, the AICD offers many
publication possibilities for the CNS such as the
discussion of ethical issues, the presentation of case
studies, and the disclosure of standards of care as
they emerge.

Researcher

In addition to the multitude of publication
possibilities, the CNS plays an important research role
in the management of the AICD patient. Through
research, problems that are identified in practice can

be solved.

Initially, the CNS can critically evaluate and
integrate research findings from multiple disciplines
into nursing practice (American Association of Critical
Care Nurses, 1988).   This facilitates in not only
solving clinical problems but also meets the legal
requirements established for formulation of standards of
care. Unit procedures should be similar to those
recommended in literature, particularly in topic areas
that have been researched and have a scientific base
(Clark & Garry, 1991). With the AICD patient, research
findings from the critical care setting, such as the
recognition of increased defibrillation thresholds
with certain drugs, can be written into the emergency
room's standards of care with the goal of improving
resuscitation outcomes.

Additionally, the CNS can generate research
questions from problems identified in practice.
Research questions specific for the AICD patient
population could cover such areas as the ethical
implications of AICD implantation, the relationship
between family support and the length of patient
survival, the AICD patient's quality of life

perceptions in comparison to the quality of life
perceptions held by patient's who have a permanent
pacemaker, the effect the AICD has on the patient's
body image and self concept, the evaluation of CAI
instruction versus lecture sessions in the education of
patients and nurses on the AICD, and the effect
altitude changes associated with flight transport have
upon AICD function. Research opportunities like these
are numerous and will continue to increase for the CNS
as the AICD patient population crosses into other
medical disciplines like obstetrics and pediatrics.

As the AICD appears in other disciplines,
collaborative research opportunities for the CNS will
emerge. The CNS by role definition participates in the
design and conduct of research (American Association of
Critical Care Nurses, 1988). The CNS because of
his/her advanced clinical experience and knowledge of
research design is in a great position to assist,
guide, evaluate and disseminate research findings
obtained in these collaborative endeavors.

Consultant

The CNS provides consultation services to health
care providers and consumers within the institution

and community (American Association of Critical Care Nurses, 1988). Patient care, family problems, clinical aspects of nursing management and clinical research are examples of areas the CNS can address through the consultative process.

A major part of this CNS consultant role is the providing of expert knowledge in the form of educational inservices to other health care providers. In cases of emergency, the sharing of this expert knowledge by the CNS on the care of the patient with an ACID can be a life saving intervention. For instance, emergency care providers, especially mobile squads who do not work routinely with AICD patients, may be unaware of the ability to defibrillate the AICD patient or the need to change external paddle positions for successful defibrillation. Formally, the CNS offers educational information in the form of consultation services to alert these other disciplines to the special needs of the AICD patient, thus increasing the patient's chance for survival.

Informally, the CNS acts as a consultant in the emergency room and critical care setting by being available at the patient's bedside to answer the staff

nurse's questions concerning AICD function and patient management. Also, family members may elicit explanations on AICD technology, support services and requirements for home care. The mutual and creative problem-solving that occurs during these informal consultative interactions serves as a catalyst for further CNS professional development, thus profoundly influencing nursing practice.

Summary

The AICD offers many challenges for emergency room and critical care clinical nurse specialists. The four CNS sub-roles of clinical expert, educator, researcher and consultant play key parts in the CNS's ability to meet these future demands. It is imperative that the nursing profession keep updated in its practice and disseminate relevant nursing and medical research findings. The CNS is in an excellent position to address these concerns and institute actions that will provide the AICD patient quality care.

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Your programmable solution to sudden cardiac death:

Ventak 1550 AICD. (1989). St. Paul, Mn: Cardiac

Pacemakers, Inc.

Appendix A

Paddle A: Place right of upper sternum and below right clavicle (American Heart Association, 1987).

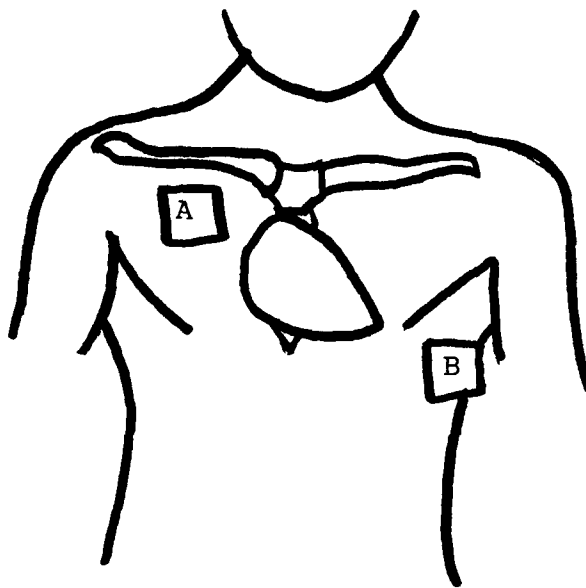Paddle B: Place left of left nipple in the anterior axillary line (American Heart Association, 1987)
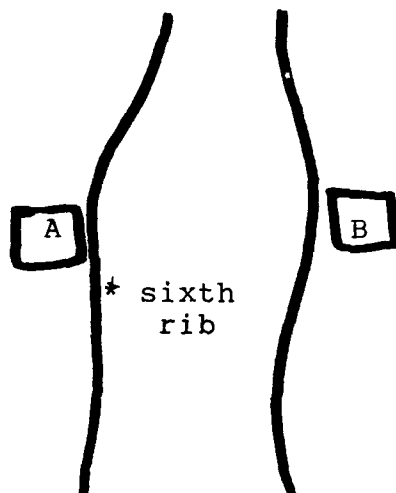

Fig. 1 Standard placement of external defibrillation paddles

Appendix B

Paddle A: Place anteriorly over precordium

(American Heart Association, 1987),

Paddle B: Place posteriorly behind the heart

(American Heart Association, 1987).

* sixth
  rib

Left lateral position

Fig. B Paddle placement adjustment to

anterior-posterior position for AICD patient's

needing external defibrillation.